State of Hawaii
DEPARTMENT OF LAND AND NATURAL RESOURCES
Division of Aquatic Resources
Honolulu, Hawaii 96813

June 9, 2011

Board of Land
and Natural Resources
Honolulu, Hawaii

Request for Authorization and Approval to Issue a Papahānaumokuākea Marine National Monument Research Permit to Megan Donahue, University of Hawaii, Hawaii Institute of Marine Biology, for Access to State Waters to Conduct Bioerosion Study Activities

The Division of Aquatic Resources (DAR) hereby submits a request for your authorization and approval for issuance of a Papahānaumokuākea Marine National Monument research permit to Megan Donahue, assistant researcher, University of Hawaii, Hawaii Institute of Marine Biology, pursuant to § 187A-6, Hawaii Revised Statutes (HRS), chapter13-60.5, Hawaii Administrative Rules (HAR), and all other applicable laws and regulations.

The research permit, as described below, would allow entry and research activities to occur in Papahānaumokuākea Marine National Monument (Monument), including the NWHI State Marine Refuge and the waters (0-3 nautical miles) surrounding the following sites:

- Nihoa Island
- Necker Island (Mokumanamana)
- French Frigate Shoals
- Gardner Pinnacles
- Maro Reef
- Laysan Island
- Lisianski Island
- Pearl and Hermes Atoll
- Kure Atoll

The activities covered under this permit would occur between June 1, 2011 and November 30, 2011.

INTENDED ACTIVITIES

The Applicant is proposing to measure bioerosion rates, bioeroder community composition (i.e. hydrozoans, bryozoans, barnacles, and tiny mollusks) and physical parameters of their associated microhabitats at up to 10 different reef sites in Papahanaumokuakea Marine National Monument. The purpose of these activities is to test the effectiveness of using bioerosion rates and bioeroder communities as indicators of climate change, specifically ocean acidification.

To carry out this survey, the applicant is requesting to place calcium carbonate blocks as settling substrate for bioeroders; deploy a temporary sensor array to measure temperature, pH, salinity, and oxygen concentration at each site; collect water and dead coral samples; and use a water tracing dye to measure water retention in crevice sites.

Specifically this will involve:

1. Placing 20 small calcium carbonate blocks at each of 10 different sites
2. Deploying a sensor array at each site, which would be removed before moving to the next site. The temporary array would be held in place by a stake or weighted sled.
3. Collecting up to 26.15 liters of sea water at each site
4. Collecting up to 20 small pieces of dead *Porites compressa* at each site
5. Injecting up to 0.6 liters of rhodamine solution, a common water tracing dye, at five crevice sites within each research site. It should be noted that the Applicant would be using a concentration of dye determined safe for drinking water.

The activities proposed by the applicant directly support the Monument Management Plan's priority management needs 3.1 – Understanding and Interpreting the NWHI (through action plan 3.1.1 – Marine Conservation Science).

The activities described above may require the following regulated activities to occur in State waters:

- ☒ Removing, moving, taking, harvesting, possessing, injuring, disturbing, or damaging any living or nonliving monument resource
- ☒ Drilling into, dredging, or otherwise altering the submerged lands other than by anchoring a vessel; or constructing, placing, or abandoning any structure, material, or other matter on the submerged lands
- ☒ Discharging or depositing any material or matter into the Monument
- ☒ Touching coral, living or dead
- ☒ Swimming, snorkeling, or closed or open circuit SCUBA diving within any Special Preservation Area or Midway Atoll Special Management Area

REVIEW PROCESS:

The permit application was sent out for review and comment to the following scientific and cultural entities: Hawaii Division of Aquatic Resources, Hawaii Division of Forestry and Wildlife, Papahānaumokuākea Marine National Monument (NOAA/NOS), NOAA Pacific Islands Regional Office (NOAA-PIRO), United States Fish and Wildlife Service Hawaiian and Pacific Islands National Wildlife Refuge Complex Office, and the Office of Hawaiian Affairs (OHA). In addition, the permit application has been posted on the Monument Web site since March 10th, giving the public an opportunity to comment. The application was posted within 40 days of its receipt, in accordance with the Monument's Public Notification Policy.

Comments received from the scientific community are summarized as follows:

Scientific reviews support the acceptance of this application.

Concerns raised:

1. Mercuric Chloride is highly toxic – what is the applicant's handling and safety protocols?

The Applicant states that mercuric chloride is used, by necessity, for storing samples for measurement of total alkalinity. For each water sample, 50 microliters of this biological fixing agent are required; there would be no more than 400mL of 50% saturated solution of HgCl2 shipboard and no more than 200mL per container. By using small containers of this material, they minimize the size of potential spills. The HgCl2 solution would be kept in plastic, screw-top containers to avoid the possibility of breakage. If a spill were to occur, dilution and mixing in the ocean seawater would quickly result in undetectable concentration levels. All necessary precautions are taken to prevent such a spill and prevent mercury from entering the food chain; the Applicant has developed spill response procedures. The Applicant points out that the use of HgCl2 as a fixing agent for water samples, particularly in sampling for total alkalinity, is a standard and widespread method in the field of chemical oceanography.

2. Regarding the fixed array, how large and heavy is the weighted sled, i.e., how much disturbance would its deployment cause?

The Applicant states that the weighted sled is approximately 0.5m × 0.25m × 0.2m (L×W×H) and weighs 30 pounds. They are preparing a test deployment on the forereef outside Kaneohe Bay to ensure that it is adequately weighted and designed for forereef conditions. Ultimately, deployment would depend on suitable conditions: this means that they must be confident that, once placed, the sled would not move during the 1-3 day deployment, as movement would risk both damaging the neighboring coral and the instruments. Both Megan Donahue (PI) and Nyssa Silbiger (Field PI) have extensive experience placing subtidal experiments in areas that experience high wave energy. The Applicant also states that they will not risk either the coral or the equipment by deploying the sled unsecured or inadequately weighted for the conditions.

Comments received from the Native Hawaiian community are summarized as follows:

Cultural reviews support the acceptance of this application. No concerns were raised.

Comments received from the public are summarized as follows:

No comments were received from the public on this application.

Additional reviews and permit history:

Are there other relevant/necessary permits or environmental reviews that have or will be issued with regard to this project? (e.g. MMPA, ESA, EA) Yes ☒ No ☐
If so, please list or explain:

- The proposed activities are in compliance with the National Environmental Policy Act.
- The Department has made an exemption determination for this permit in accordance chapter 343, HRS, and Chapter 11-200, HAR. See Attachment ("DECLARATION OF

EXEMPTION FROM THE PREPARATION OF AN ENVIRONMENTAL ASSESSMENT UNDER THE AUTHORITY OF CHAPTER 343, HRS AND CHAPTER 11-200 HAR, FOR PAPAHĀNAUMOKUĀKEA MARINE NATIONAL MONUMENT RESEARCH PERMIT TO MEGAN DONAHUE, HAWAII INSTITUTE OF MARINE BIOLOGY, FOR ACCESS TO STATE WATERS TO CONDUCT BIOEROSION STUDY ACTIVITIES UNDER PERMIT PMNM-2011-032")

Has Applicant been granted a permit from the State in the past? Yes ☐ No ☒
If so, please summarize past permits:

Have there been any a) violations: Yes ☐ No ☒
b) Late/incomplete post-activity reports: Yes ☐ No ☒

Are there any other relevant concerns from previous permits? Yes ☐ No ☒

STAFF OPINION

DAR staff is of the opinion that Applicant has properly demonstrated valid justifications for her application and should be allowed to enter the NWHI State waters and to conduct the activities therein as specified in the application with certain special instructions and conditions, which are in addition to the Papahānaumokuākea Marine National Monument Research Permit General Conditions. All suggested special conditions have been vetted through the legal counsel of the Co-Trustee agencies (see Recommendation section).

MONUMENT MANAGEMENT BOARD OPINION

The MMB is of the opinion that the Applicant has met the findings of Presidential Proclamation 8031 and this activity may be conducted subject to completion of all compliance requirements. The MMB concurs with the special conditions recommended by DAR staff.

RECOMMENDATION

Based on the attached proposed declaration of exemption prepared by the department after consultation with and advice of those having jurisdiction and expertise for the proposed permit actions:

1. That the Board declare that the actions which are anticipated to be undertaken under this permit will have little or no significant effect on the environment and is therefore exempt from the preparation of an environmental assessment.

2. Upon the finding and adoption of the department's analysis by the Board, that the Board delegate and authorize the Chairperson to sign the declaration of exemption for purposes of recordkeeping requirements of chapter 343, HRS, and chapter 11-200, HAR.

3. That the Board authorize and approve a Research Permit to Megan Donahue, Hawaii Institute of Marine Biology, with the following special conditions:

a. This permit is not to be used for nor does it authorize the sale of collected organisms. Under this permit, the authorized activities must be for noncommercial purposes not involving the use or sale of any organism, by-products, or materials collected within the Monument for obtaining patent or intellectual property rights.

b. The permittee may not convey, transfer, or distribute, in any fashion (including, but not limited to, selling, trading, giving, or loaning) any coral, live rock, or organism collected under this permit without the express written permission of the Co-Trustees.

c. To prevent introduction of disease or the unintended transport of live organisms, the permittee must comply with the disease and transport protocols attached to this permit.

d. Tenders and small vessels must be equipped with engines that meet EPA emissions requirements.

e. Refueling of tenders and all small vessels must be done at the support ships and outside the confines of lagoons or near-shore waters in the State Marine Refuge

f. No fishing is allowed in State Waters except as authorized under State law for subsistence, traditional and customary practices by Native Hawaiians.

Respectfully submitted,

Administrator

APPROVED FOR SUBMITTAL

William J. Aila, Jr.
Chairperson

Papahānaumokuākea Marine National Monument

RESEARCH Permit Application

NOTE: ***This Permit Application (and associated Instructions) are to propose activities to be conducted in the Papahānaumokuākea Marine National Monument. The Co-Trustees are required to determine that issuing the requested permit is compatible with the findings of Presidential Proclamation 8031. Within this Application, provide all information that you believe will assist the Co-Trustees in determining how your proposed activities are compatible with the conservation and management of the natural, historic, and cultural resources of the Papahānaumokuākea Marine National Monument (Monument).***

ADDITIONAL IMPORTANT INFORMATION:

- Any or all of the information within this application may be posted to the Monument website informing the public on projects proposed to occur in the Monument.

- In addition to the permit application, the Applicant must either download the Monument Compliance Information Sheet from the Monument website OR request a hard copy from the Monument Permit Coordinator (contact information below). The Monument Compliance Information Sheet must be submitted to the Monument Permit Coordinator after initial application consultation.

- Issuance of a Monument permit is dependent upon the completion and review of the application and Compliance Information Sheet.

INCOMPLETE APPLICATIONS WILL NOT BE CONSIDERED

Send Permit Applications to:
Papahānaumokuākea Marine National Monument Permit Coordinator
6600 Kalaniana'ole Hwy. # 300
Honolulu, HI 96825
nwhipermit@noaa.gov
PHONE: (808) 397-2660 FAX: (808) 397-2662

SUBMITTAL VIA ELECTRONIC MAIL IS PREFERRED BUT NOT REQUIRED. FOR ADDITIONAL SUBMITTAL INSTRUCTIONS, SEE THE LAST PAGE.

Papahānaumokuākea Marine National Monument
Permit Application Cover Sheet

This Permit Application Cover Sheet is intended to provide summary information and status to the public on permit applications for activities proposed to be conducted in the Papahānaumokuākea Marine National Monument. While a permit application has been received, it has not been fully reviewed nor approved by the Monument Management Board to date. The Monument permit process also ensures that all environmental reviews are conducted prior to the issuance of a Monument permit.

Summary Information

Applicant Name: Megan Donahue
Affiliation: Hawaii Institute of Marine Biology

Permit Category: Research
Proposed Activity Dates: 05/15/11-11/15/11
Proposed Method of Entry (Vessel/Plane): R/V Hi'ialakai
Proposed Locations: Shallow water reef (<100 ft depth) focused on bioeroder communities in forereef and lagoon habitats. Specific locations for the study will depend on cruise logistics.

Estimated number of individuals (including Applicant) to be covered under this permit: Four
Estimated number of days in the Monument: 30 days (one research cruise)

Description of proposed activities: (complete these sentences):

a.) The proposed activity would…

measure bioerosion rates, bioeroder community composition, and associated microhabitat variation on reefs in the NWHI to evaluate whether internal bioeroders can serve as indicators of community response to ocean acidification on coral reefs. Taking advantage of the substantial natural variation in pH on small scales within lagoonal reefs, we will test whether the total bioerosion rate and/or the community composition of internal bioeroders responds to natural spatial variation in pH within coral reefs along the Archipelago. Bioerosion rates will be measured using microCT scans of coral blocks to get a 3D image of the eroded material, which gives a better estimate of bioerosion rate than traditional buoyant weight technique and allows characterization of distinct bioeroder groups. Community composition will be measured using a ReefChip, a molecular microarray that will be customized to detect and quantify the bioeroder community. If effective, this method would be an efficient and inexpensive way to detect community level effects of ocean acidification in remote areas.

b.) To accomplish this activity we would ….

(i) measure bioerosion rates by installing twenty small calcium carbonate blocks (5x5x2cm) on reef substrate at each site. We will deploy blocks at 4-5 lagoon sites and 4-5 forereef sites (a site is a 20m x 20m area of reef); the total number of blocks installed in PMNM will not exceed 200. These blocks will act as a settling substrate for bioeroding organisms. Blocks will be affixed to reef substrate marine epoxy and carefully avoiding live coral. Prior to deployment, each block will be scanned by microCT (to create a 3D image of the block) and autoclaved; blocks will be retrieved after one year. Retrieved blocks will be rescanned by microCT and sampled for bioeroding organisms. Pre- and post-scans will be used to estimate the rate of bioerosion of the calcium carbonate reef framework across the Archipelago. Bioeroder community composition will be measured using the ReefChip microarray.
(ii) measure variation in the bioeroder community by collecting thirty small pieces (5x5x5cm) of dead coral skeleton at each site. These pieces of reef substrate will be sampled for bioeroding fauna using both traditional taxonomic identification and the ReefChip microarray.
(iii) measure microhabitat variation in water chemistry by collecting water samples adjacent to each block for analysis of pH, total alkalinity, nutrient concentration, particulates, and chlorophyll a concentration.
(iv) measure variation in physical variables by deploying an acoustic Doppler velocimeters (Nortek AS Vector) and a multiparameter sonde for continuous measurement (up to 5 days) at each site. A second, smaller acoustic Doppler velocimeter (Nortek AS Vectrino) and handheld multiparameter sonde will be used by divers to measure microhabitat variation within each site.
(v) measure variation in retention time by injecting a solution of fluorescent dye (rhodamine WT) into reef crevices and sampling water in the crevice until the dye concentration is indistinguishable from background. The rate of water retention in the crevice is calculated from the rate at which the dye concentration declines.

c.) This activity would help the Monument by …
evaluating whether internal bioeroders can serve as indicators of community response to ocean acidification on coral reefs. The community structure and function of bioeroding organisms may have a major effect on coral reef resilience: the sponges, polychaete worms, and tiny mollusks that comprise bioeroder communities control the strength and complexity of the coral reef framework, which is the habitat for more charismatic coral reef organisms. Shifts in the composition and functioning of these out-of-sight, but fundamental members of coral reef ecosystems may change the accretion-erosion balance of coral reefs. The methods developed here will help managers anticipate the likely affects of ocean acidification on bioeroder communities and bioerosion rates. If effective, this method would be an inexpensive way to detect community level effects of ocean acidification in remote areas.

Other information or background:
Location of study: Our study site selection will be dictated by cruise logistics. We plan to sample 4-5 lagoon sites and 4-5 forereef sites. If possible, we will co-locate our deployments with current NOAA-CRED deployments of ARMS or CAUs to facilitate retrieval.

Section A - Applicant Information

1. Applicant

Name (last, first, middle initial): Donahue, Megan J.

Title: Assistant Researcher, Hawaii Institute of Marine Biology

1a. Intended field Principal Investigator (See instructions for more information):
Nyssa Silbiger, graduate student

2. Mailing address (street/P.O. box, city, state, country, zip):
Hawaii Institute of Marine Biology, [redacted]

Phone: [redacted]

Fax: [redacted]

Email: [redacted]

For students, major professor's name, telephone and email address:

3. Affiliation (institution/agency/organization directly related to the proposed project):
Hawaii Institute of Marine Biology (HIMB), University of Hawaii at Manoa

4. Additional persons to be covered by permit. List all personnel roles and names (if known at time of application) here (e.g. John Doe, Research Diver; Jane Doe, Field Technician):
Nyssa Silbiger, graduate student, research diver
Oscar Guadayol i Roig, post-doctoral researcher, research diver
unspecified research diver

Section B: Project Information

5a. Project location(s):

		Ocean Based	
☒ Nihoa Island	☐ Land-based	☒ Shallow water	☐ Deep water
☒ Necker Island (Mokumanamana)	☐ Land-based	☒ Shallow water	☐ Deep water
☒ French Frigate Shoals	☐ Land-based	☒ Shallow water	☐ Deep water
☒ Gardner Pinnacles	☐ Land-based	☒ Shallow water	☐ Deep water
☒ Maro Reef			
☒ Laysan Island	☐ Land-based	☒ Shallow water	☐ Deep water
☒ Lisianski Island, Neva Shoal	☐ Land-based	☒ Shallow water	☐ Deep water
☒ Pearl and Hermes Atoll	☐ Land-based	☒ Shallow water	☐ Deep water
☒ Midway Atoll	☐ Land-based	☒ Shallow water	☐ Deep water
☒ Kure Atoll	☐ Land-based	☒ Shallow water	☐ Deep water
☐ Other			

NOTE: There is a fee schedule for people visiting Midway Atoll National Wildlife Refuge via vessel and aircraft.

Location Description:
We anticipate our sampling sites (4-5 lagoon sites and 4-5 forereef sites) to be in shallow water lagoon and forereef habitats between French Frigate Shoals and Kure. Cruise logistics will influence the specific locations for deployment, but we anticipate including lagoon sites at French Frigate Shoals, Pearl & Hermes Atoll, Midway, and/or Kure, and would prefer to collocate our forereef sites with existing ARMS deployments at French Frigate Shoals, Lisianski, Pearl & Hermes, and Kure. Due to limited shiptime this year and competing priorities in selecting locations for sampling, I have listed all possible sites. This ensures maximum flexibility due to weather or unforeseen changes to cruise schedules. All activities will occur within the area outlined by the following coordinates.

Location:	Longitude	Latitude
Kure Atoll	-178.19706492000	28.55825235580
Kure Atoll	-178.19623585400	28.29958375730
Kure Atoll	-178.45987884800	28.29958375730
Kure Atoll	-178.46070791400	28.55742328970
Midway Atoll	-177.19638223300	28.37419969920
Midway Atoll	-177.19721129900	28.13377055310
Midway Atoll	-177.52800864100	28.13459961920
Midway Atoll	-177.52800864100	28.37419969920
Pearl and Hermes Atoll	-176.08850981800	28.04643025580
Pearl and Hermes Atoll	-175.63289162600	28.04539944540
Pearl and Hermes Atoll	-175.63289162600	27.70729363750
Pearl and Hermes Atoll	-176.08954062900	27.70626282710
Lisianski Island	-173.67292570900	26.25150771120
Lisianski Island	-173.67292570900	25.83942708400

Lisianski Island	-174.23095155800	25.83942708400
Lisianski Island	-174.23095155800	26.25150771120
Laysan Island	-171.47900122300	25.96027179830
Laysan Island	-171.47725234300	25.65596666490
Laysan Island	-171.97918092500	25.65771554490
Laysan Island	-171.97918092500	25.96202067840
Maro Reef	-170.18133220600	25.69968866680
Maro Reef	-170.17958332600	25.21524888540
Maro Reef	-171.00505472200	25.21524888540
Maro Reef	-171.00505472200	25.69968866680
Gardner Pinnacles	-167.74832319300	25.26070709440
Gardner Pinnacles	-167.75087047400	24.34878019150
Gardner Pinnacles	-168.36221811900	24.35132747340
Gardner Pinnacles	-168.36476540100	25.26070709440
French Frigate Shoals	-165.93465851400	23.94630965900
French Frigate Shoals	-165.93465851400	23.56421738120
French Frigate Shoals	-166.45685129400	23.56421738120
French Frigate Shoals	-166.45685129400	23.94630965900

5b. Check all applicable regulated activities proposed to be conducted in the Monument:

☒ Removing, moving, taking, harvesting, possessing, injuring, disturbing, or damaging any living or nonliving Monument resource

☒ Drilling into, dredging, or otherwise altering the submerged lands other than by anchoring a vessel; or constructing, placing, or abandoning any structure, material, or other matter on the submerged lands

☐ Anchoring a vessel

☐ Deserting a vessel aground, at anchor, or adrift

☒ Discharging or depositing any material or matter into the Monument

☒ Touching coral, living or dead

☐ Possessing fishing gear except when stowed and not available for immediate use during passage without interruption through the Monument

☐ Attracting any living Monument resource

☐ Sustenance fishing (Federal waters only, outside of Special Preservation Areas, Ecological Reserves and Special Management Areas)

☐ Subsistence fishing (State waters only)

☒ Swimming, snorkeling, or closed or open circuit SCUBA diving within any Special Preservation Area or Midway Atoll Special Management Area

6 Purpose/Need/Scope ***State purpose of proposed activities:***
Bioerosion, the removal of CaCO3 reef structure by biological agents (Neumann 1966), is a natural process that influences the mechanical stability, structural complexity, and net accretion rate of coral reefs. Extensive bioerosion can compromise the mechanical stability and structural complexity of reefs, thereby increasing susceptibility to storm damage (Hutchings 1986) and decreasing habitat availability for other reef organisms (Hoegh-Guldberg et al. 2007), and organisms that rely on emergent land, including Hawaiian monk seals, sea turtles, and sea birds. Bioeroders may be classified into three functional groups: microborers (e.g., euendoliths), macroborers (e.g., sponges, polychaetes, and bivalves), and grazers (e.g., urchins and fish). Micro- and macroborers erode the interior of reef substrate and are typically more abundant in dead coral substrate than live coral (Highsmith 1981). In the PMNM, micro- and macro-borers communities have remained largely unstudied and, although grazer density has been estimated on a few reefs, erosion rates due to bioeroders of any group have never been measured directly.

The community of bioeroders are a good target for detecting community changes in response to ocean acidification: (i) bioerosion is integral to long-term reef sustainability (Grigg 1982), (ii) bioerosion rates are sensitive to pH (Tribollet et al 2009), (iii) bioeroder community composition may shift in response to changes in pH, and (iv) applying new technologies will allow the efficient measurement of bioerosion rates and community composition that is critical for managers. The effective use of bioerosion rates as a monitoring and management tool requires distinguishing the effects of ocean acidification from other environmental parameters; this is the challenge that motivates this project.

Anthropogenic climate change is an environmental threat that challenges conventional management solutions. The 38 Gt of anthropogenic carbon dioxide (CO2) emitted each year has resulted in the highest concentrations of atmospheric CO2 in the last 740,000 years (Petit et al 1999), resulting in increased sea-surface temperature, sea-level rise, and alteration of the carbon cycle in our oceans (IPCC 2007). In Hawai'i, the Hawai'i Ocean Timeseries has detected a 0.075 decrease in mean annual pH at Station Aloha over the past 20 years (Doney et al 2009); globally, a further decrease of 0.14-0.35 pH units is predicted for the 21st century (IPCC 2007). Despite these predictions, the effects of ocean acidification on coral reef communities are unknown and unregistered because we lack effective monitoring tools.

Available predictions of pH in the coastal zones (Orr et al 2005, IPCC 2007) are based on models of open ocean values. Applying these predictions to coral reef ecosystems is complicated by new data highlighting the temporal and spatial variability of pH in coastal waters (Gagliano et al 2010). These new studies show substantial small scale variation in pH within and between reef habitats, including a range of natural variation that can be as large as predicted changes in ocean acidification at the global scale (Gagliano et al 2010, K. Anthony, pers comm). For instance, recent work shows pH

variation from 7.82 to 8.12 in the shallow waters of Kāne'ohe Bay (Miles 2010). This is not unexpected: studies of reef metabolism indicate that these differences in pH may be influenced by relative abundance of respiring and photosynthesizing organisms, flushing rate of the overlying water mass (and, therefore, the presence and thickness of boundary layers), and the history of the water mass. While this variation in pH complicates our predictions of coral reef response to ocean acidification, it also provides an opportunity to examine community-level responses to pH variation and, further, how communities may respond to future change.

In the proposed project, we take advantage of natural variation in the pH over small spatial scales in lagoonal reefs to examine how bioeroding communities may respond to ocean acidification and to test the effectiveness of using bioerosion rates and bioeroder communities as indicators of climate change in remote coral reef systems. We include forereef sites to decrease the within-site variation and examine Archipelago-wide patterns. We use a sophisticated sensor array (ReefSense) deployed at our study sites to measures the microhabitat variation on the reef and its relationship to spatial patterns in the bioeroding community and bioerosion rates. Bioeroder community composition will be assessed using a combination of taxonomic and molecular techniquest, including the ReefChip microarray, which is under development in Dr. Rob Toonen's laboratory. The ReefChip allows species-specific identification of organisms in a mixed environmental sample. Concomitant benefits of the project include accurate measurement of crustose coralline algal growth using microCT and tests for the presence of undetected alien species in the NWHI using the ReefChip technology.

The specific objectives identified for this project are:
1) Characterize microhabitat variation within and between reefs using ReefSense sensor array
- Use ReefSense to measure light, flow, temperature, pH, and other environmental variables at high spatial and temporal resolution on the reef
- Identify patterns of spatiotemporal variation in pH : are locations on the reef consistently high or low? steady or variable? asynchronous in time or space?
- Focus ReefSense on locations where coral blocks are deployed and bioeroder communities are sampled

2) Characterize variation in bioeroder community composition within reefs and across the Archipelago using ReefChip
- Contribute sequences to ReefChip to customize it to the bioeroding community of the Hawaiian Archipelago
- Using ReefChip, test for undetected alien species among bioeroders of the NWHI

3) Measure bioerosion rates using microCT technology
- Compare $CaCO_3$ loss within and between reefs across the Archipelago
- Measure $CaCO_3$ accretion by CCA
- Use 3-dimensional reconstructions to associate specific patterns of erosion with specific taxa

4) Evaluate the relationship between pH, bioerosion rate, and bioeroder community composition

• Are there conditions under which bioerosion rate and/or bioeroder community composition are good indicators of changing pH?

7. Answer the Findings below by providing information that you believe will assist the Co-Trustees in determining how your proposed activities are compatible with the conservation and management of the natural, historic, and cultural resources of the Monument:

The Findings are as follows:

a. How can the activity be conducted with adequate safeguards for the cultural, natural and historic resources and ecological integrity of the Monument?
We are a team of conservation biologists, teaching and studying the science of how best to manage and conserve the ecological integrity of marine ecosystems. Therefore, minimizing our impact to the ecosystem we are trying to conserve is a natural and inherent part of any research we conduct within the Monument. It is my goal to inculcate in students and trainees that work with me a respect for the resources that we study. This respect requires that we carefully consider the impact of our study design, that our study design is robust and will produce useful results, and that our work is disseminated to scientists and managers to improve the conservation efforts in these systems. In developing our research methods, we have taken care to minimize any potential negative impacts to the system as outlined in the methods section below. We believe that we have implemented every reasonable safeguard for the natural resources and ecological integrity of the Monument in our research, and we do not expect any detectable impact from our research sampling. As outlined in detail below, our sample size and methodologies have all been selected to provide robust and scientifically rigorous information to managers with the least possible impact to the natural resources of the Monument.

Our work will not impact historic resources: we do not set foot on land within the Monument, and we report but do not touch any submerged artifacts discovered during our diving activities.

As in previous years, each participant is required to participate in a Cultural Briefing prior to departure on the Hi'ialakai. Each member of my team is aware of the unique ecological status of the Monument, and this briefing reminds all team members of the cultural significance of the place. However, this separation of natural, cultural, and historic resources is itself a western construct. Stewardship of natural resources is a central theme in the relationship that Hawaiians have with the natural world and, thus, there is no difference between a natural and cultural resource. Papahānaumokuākea is a sacred place to native Hawaiians; a place that is included in the oral history of chants and meles; a place where native Hawaiians have travelled for hundreds of years. We strive to approach our work in the Monument with the same humility, wonder, and regard for the natural world as these travelers. We intend that our research in the Monument will give a strong foundation to stewardship practices that best manage and protect the coral reefs ecosystems of Papahānaumokuākea. Native Hawaiians learned when and where important food fish were spawning and, understanding their potential impact on fish populations, protected these times and areas. In a similar way, we will be learning about the bioeroding communities of the Monument and trying to understand and mitigate the impacts of anthropogenic climate change

on these communities. This knowledge will then be used to protect and manage the resources of the Monument just as Native Hawaiians protected and managed resources of their ahupua'a.

b. How will the activity be conducted in a manner compatible with the management direction of this proclamation, considering the extent to which the conduct of the activity may diminish or enhance Monument cultural, natural and historic resources, qualities, and ecological integrity, any indirect, secondary, or cumulative effects of the activity, and the duration of such effects?
The research we propose here is the type of research directly mandated by the Proclamation: it is "research designed to further understanding of monument resources and qualities… [and] will assist in the conservation and management of the monument". The research we propose is necessary to both maintain ecosystem integrity and provide for adaptive ecosystem management in the face global climate change. As outlined above and below, our activities have no detectable effect to diminish Monument resources, nor have any known indirect, secondary or cumulative effects on the ecosystem or resources therein. Because of concerned about cumulative impacts, a threat assessment of the activities in the Monument have been conducted (Selkoe et al. 2008), and a compiled cumulative impact threat map of the Monument (Selkoe et al. 2009) has been provided to the co-trustees for use in future management decisions.

Our proposed activities are minimally invasive. Coral blocks will be attached to bare rock or dead coral and removed with a minimum of disturbance. The small samples of dead coral skeleton (5x5x5cm) collected from reefs are a tiny fraction of the reef substrate removed naturally by external bioeroders (e.g., urchins, parrotfish). Negative impacts on the reefs, atoll, and Monument are exceedingly small, while the positive impacts of the results of our research are Monument-wide.

Our overriding goal is to provide scientific information to managers so that the Papahānaumokuākea Marine National Monument can be managed and protected based on policy grounded in sound science. Our divers are experienced in moving in and around coral and coral reefs so as to not cause damage. Each diver has been through intensive dive training and is a certified scientific diver with the American Association of Underwater Scientists. We are conducting these activities already in Kāne'ohe Bay, allowing us to hone our methods to minimize impacts on the Monument.

c. Is there a practicable alternative to conducting the activity within the Monument? If not, explain why your activities must be conducted in the Monument.
There are no alternatives to conducting this activity within the monument. Our research is aimed at understanding how bioerosion processes shift along the Hawaiian Archipelago. There is no practicable alternative to doing this in the Monument because it is the reefs in the Monument that will need to be managed. For example, the same information from reefs in the main Hawaiian Islands is interesting – indeed, we are pursuing a similar study in Kaneohe Bay-- but there is no basis upon which to say that the reefs in the Monument are like the Main Hawaiian Island reefs. In fact, we know they are not the same -- Kaneohe Bay has many introduced species that are not present in the Monument, and a concomitant benefit of our study is understanding the potential impacts of these introduced species.

d. How does the end value of the activity outweigh its adverse impacts on Monument cultural, natural and historic resources, qualities, and ecological integrity?
We anticipate truly negligible impact of our study on the resources of the Monument and, therefore, believe that the end value of this research clearly outweighs that imperceptible impact. Further, an understanding of bioerosion rates across this region will greatly increase the decision-making capacity of the co-trustees in dealing with the potential impacts of global climate change within the Monument.

e. Explain how the duration of the activity is no longer than necessary to achieve its stated purpose.
It is anticipated that deploying the coral blocks, collecting pieces of dead coral, water sampling, and collecting associated data will take 2-3 days per site with 2-4 divers. We are proposing to study 8-10 sites, depending on cruise logistics. As such, the cruise length (of 25-30 days) is shorter than ideal and is certainly no longer than is necessary to accomplish the research goals outlined in this permit application.

f. Provide information demonstrating that you are qualified to conduct and complete the activity and mitigate any potential impacts resulting from its conduct.
I have been an AAUS certified scuba diver and NAUI instructor for 18 years. I have used diving for research and trained others to dive on projects in the Gulf of Maine, California, and Hawaii, including research in other protected areas like the Channel Islands National Park. I have a PhD in Ecology from the University of California, Davis and have publications on marine ecology and spatial population dynamics relevant to this study. While this is my first permit application for work in the Monument, I was privileged to enter the Monument on the May 2010 cruise to support other projects, including Scott Godwin's (PMNM) surveys of invasive species and Rob Toonen's connectivity sampling. My experience on last year's cruise was excellent preparation for the study proposed here. The field PI for the project is Nyssa Silbiger, who assisted Derek Smith on the May 2010 cruise. Nyssa is a graduate student in my laboratory and an experienced coral reef diver; her masters research was performed at Aquarius, an underwater ocean laboratory located in the Florida Keys National Marine Sanctuary.

g. Provide information demonstrating that you have adequate financial resources available to conduct and complete the activity and mitigate any potential impacts resulting from its conduct.
The project proposed here is a collaboration between the Donahue (sampling of bioeroders), Thomas (sampling of the physical environment), and Toonen (ReefChip) laboratories at the Hawaii Institute of Marine Biology. There are adequate finances in the Donahue lab and the PMNM-HIMB partnership to conduct and complete all the research outlined herein. This research is currently or has been previously funded by a combination of the NWHI PMNM-HIMB partnership, the University of Hawaii, and NSF.

h. Explain how your methods and procedures are appropriate to achieve the proposed activity's goals in relation to their impacts to Monument cultural, natural and historic resources, qualities, and ecological integrity.
Our choice of sites will be guided by the vessel and Monument staff while aboard the NOAA vessel Hi'ialakai. We generally avoid any sites that are identified as culturally significant, and

focus our activities in regions that maximize the safety of the crew while ensuring that the proposed work will be completed. The questions we are addressing are central to understanding reef erosion processes and the Monument's response to global climate change. Any negative impacts of our study are minimal and temporary and should not alter the Monument's cultural, natural and historic resources, qualities or ecological integrity. The positive impacts of our study will help guide appropriate stewardship practices to preserve and manage the qualities and integrity of the Monument's cultural and natural and historic resources. Our data is necessary to provide a strong scientific understanding of coral reef ecosystem processes by which proper management protocols can be designed. These data also are invaluable in providing a baseline with which to monitor the success of management efforts.

i. Has your vessel has been outfitted with a mobile transceiver unit approved by OLE and complies with the requirements of Presidential Proclamation 8031?
We will be on board NOAA vessel Hi'ialakai

j. Demonstrate that there are no other factors that would make the issuance of a permit for the activity inappropriate.
I have fully disclosed my intentions in this permit application. To my knowledge, there are no other factors that would make the issuance of a permit inappropriate.

8. Procedures/Methods:
There are three aspects to the study: (i) measuring microhabitat variation in the environment (ReefSense and water samples), (ii) characterizing the bioeroding community in dead coral substrate (ReefChip), and (iii) measuring bioerosion rates using experimental coral blocks (microCT). Each aspect of the study leverages cutting edge technology to rapidly advance our understanding of bioerosion on reefs and accelerate the development of effective tools for managers.

For the overall study, we expect to spend 1-5 days at each of 4-5 lagoon sites and 4-5 forereef sites, depending on cruise logistics. Below we describe the sampling methodology for each of these sites.

ReefSense
At each site, we will deploy a fixed sensor array and a mobile sensor array to characterize water exchange rates and physical background parameters. The fixed sensor array is comprised of one acoustic doppler velocimeter (a Nortek Vector) and one multiparameter YSI sonde, and it will continuously record water movement, temperature, pH, salinity, and oxygen concentration. The fixed array will be deployed for the duration of our time at the site (1-5 days, depending on cruise logistics) and will be affixed to the bottom using either (i) on a single, weighted sled deployed on non-coral substrate or (ii) attached to a fence post pounded into soft substrate near the reef. The choice of attachment will be made on site to minimize potential damage to the reef and minimize potential loss of the instruments; this decision will depend on the depth, bottom topography, and local wave conditions during our visit to the site.

A second, mobile set of instruments (a Nortek Vectrino ADV and a second YSI multiparameter sonde) will be affixed together into a single, handheld unit used by divers on the reef to (i) measure in situ the distribution of temperature, salinity, pH, O2 concentration, mean water velocity and turbulence across the study location, associated with each dead coral sample, each deployed block, and other selected microhabitats (e.g., crevices), and (ii) estimate retention times in the selected microhabitats and exchange rates between these microhabitats and the water column using rhodamine dye.

Water sample collection: We will take water samples for pH, total alkalinity, and dissolved inorganic nutrients (N and P) in the microhabitat associated with each sample of dead P. compressa skeleton (20 samples/site) and each deployed CaCO3 block (20 blocks/site). Water samples for pH, TA, and nutrient analysis will be collected using syringes (2 x 35mL syringes for pH, 2 x 140mL syringes for TA, 2 x 60mL syringes for nutrients) drawing water immediately adjacent to each block or to each sample of dead P. compressa skeleton. Therefore, 470mL will be taken at the location of each block (20 blocks/site) and at the location of each sample of dead P. compressa skeleton (20 samples/site). In select crevice microhabitats (5 crevices/site) where we expect reduced exchange rates (see below), we will take 470mL of seawater for pH, TA, and nutrients, as above, take a 500mL water sample for natural isotopes and particulate organic carbon, and take 500mL for water retention sampling (see below). Total seawater sampled at each site is 26.15L (= 9.4L for pH, TA, and nutrients x 20 deployed blocks + 9.4L for pH, TA, and nutrients x 20 dead coral samples + 7.35L for pH, TA, nutrients, natural isotopes, particulate organic carbon, and water retention x 5 crevices). Total seawater sampled in PMNM is 261.5L.

Water sample handling: All water samples will be frozen or filtered following standard procedures for each variable. For total alkalinity, each 100mL water sample must be fixed with 50 µL of 50% saturated mercuric chloride solution (MSDS sheet attached). Mercuric chloride requires careful handling, but the total amount present in the Monument will not exceed 400mL of 50% saturated mercuric chloride solution. For pH, we will analyze the water samples shipboard using a spectrophotometric method that requires a 2mM solution of m-cresol purple indicator dye (MSDS sheet attached). 50 µL of the m-cresol solution is required for each water sample during the analysis. No more than 500mL of 2mM solution of m-cresol purple indicator dye will be brought shipboard into the Monument to perform this analysis. In addition, pH seawater standards will be brought shipboard to calibrate the method; these standards are based on Tris buffers in synthetic seawater.

Retention times: At each site, we will select five microhabitats (crevices or indentations in the reef) where there is likely to be restricted water flow. We are interested in characterizing the degree of water retention in these areas, which influences the nutrient cycling and pH experienced by reef organisms. These crevices are likely to be fish habitat and are likely to be lined with algae that are adapted to low light conditions. While these light-limited areas typically do not have extensive live coral, water from

these areas may diffuse up through the reef framework to the live coral above. Independent estimates of retention times and exchange rates will be obtained by injecting small volumes of rhodamine WT dye (100mL of 60 µg/mL rhodomine solution) within each microhabitat and sampling the water periodically (60mL every 90 sec for 15 mins) until the dye concentration is indistinguishable from the background. The rate of water retention is calculated from the rate at which the dye concentration declines. Rhodamine WT is the most commonly used fluorescent dye in water tracing experiments, mainly because of its stability, its low adsortion rates, and its high detectability, which allows using very low concentrations. It is innocuous at low concentrations (e.g. Smart & Laidlaw, 1977, Rowinski & Chrzanowski, 2011; Wilson et al., 1986), and it has been extensively used in groundwater (e.g. USEPA 1991, Schipper et al., 2004) and surface water (e.g. Dierberg and DeBusk, 2005) studies, as well as in numerous oceanographic studies (e.g. Tilburg et al., 2007; Upstill-Goddard et al., 2001). It has been approved as a tracer dye in potable water in the United States (USEPA 1998). The National Sanitation Foundation Standard for Rhodamine WT is 0.1µg/L for drinking water, 10µg/Lfor water entering a drinking water plant, and 100µg/L for ground water not associated with drinking water production (USEPA 1998). The MSDS sheet for rhodamine WT and the cited references are attached.

ReefChip
At each site, we will sample up to 20 small pieces (5x5x5cm) of dead Porites compressa skeleton using bone shears or a rock hammer and chisel, taking care to avoid live coral. These samples of dead coral skeleton will contain numerous epibiotic and bioeroding organisms. In the Monument, samples will be stored in vials of >70% ethanol or saturated salt buffer at room temperature, given a unique sample number, and archived in a database. Upon return to HIMB, some samples will be carefully dissolved in an acid solution to extract the bioeroding organisms intact from the coral skeleton. These organisms will be identified, vouchered, sequenced, and stored for future DNA extraction. Other samples will be homogenized for analysis on the ReefChip (see below). All samples will be maintained in perpetuity and future permit requests for DNA sampling of species in the NWHI can be redirected to the existing tissue sample "museum" that will result from our collections.

The ReefChip is a specialized microarray composed of an array of short DNA fragments (25-35 nucleotides), each of which differentially binds to the DNA of a specific species, that are attached to a specially polished and chemically coated glass microscope slide in a process called "printing". Each unique DNA fragment, or probe, is placed in a specific position on the slide so that we can keep track of identity of the probes. Next, an environmental sample is collected (here, a piece of coral skeleton with its associated bioeroding community that has been collected and homogenized) and the DNA of all species present is isolated and extracted from the sample. The extracted environmental DNA sample is broken into smaller fragments and fluorescent molecules are attached, thereby labeling the environmental DNA. The labeled, double-stranded environmental DNA is separated into single strands and hybridized to the DNA "capture" probes on the ReefChip, forming double stranded DNA where one strand is a capture

probe and the other strand is the labeled environmental DNA. The excess labeled environmental DNA that did not match and, therefore, did not bind to the capture probes is washed away, leaving only the targeted environmental DNA that has been captured by the ReefChip. Finally, the ReefChip is dried and scanned at the wavelengths emitted by the fluorescent labels attached to the environmental DNA, producing an image of fluorescing (positive identification of a targeted species) and non-fluorescing spots (absence of a targeted species). Further, the intensity of the fluorescence of each spot can be used to estimate the quantity of the targeted species in the environmental sample.

ReefChip technology will allow us to detect, quantify, and compare species assemblages throughout the Hawaiian Archipelago at a scale beyond what would be possible using traditional taxonomic methods. This technology does not obviate the need for taxonomic expertise; like all barcoding approaches, individual specimens must be vouchered and identified to species so that a DNA sequence can be used to generate a species-specific probe. An important limitation of this technology is that it will not detect a species for which there is no species-specific probe. To manage this limitation, ReefChip also includes probes for higher taxonomic categories; e.g, a species-specific probe will detect only Mycale armata but the Demospongiae probe will detect any sponge in Class Demospongiae. This makes it possible to know when a taxonomic group is present that does not have a species-specific probe.

Bioerosion Rates

At each site, we will attach 20 small (5x5x2cm), autoclaved blocks of calcium carbonate (derived from dead Porites lobata) to non-living parts of 4-5 lagoon sites and 4-5 forereef sites in the Monument. These blocks are cut from dead P. lobata heads that wash up on exposed shores of the main Hawaiian islands. These blocks will act as settling substrate for bioeroders and will be attached to rock or dead coral using marine epoxy and cables ties, taking care to avoid live coral. Prior to deployment, calcium carbonate blocks will be scanned using an eXplore CT120 μCT scanner at Cornell University. Micro computer-aided tomography is a powerful technology for visualizing the internal structure of solid objects. The exceptional resolution of this technology allows for precise examination of coral skeletal density and the size, shape, and location of each bore hole in a given coral block. By performing pre- and post-deployment scans of the coral blocks, we can accurately measure of the amount of CaCO3 removed to calculate bioerosion rate, as well as any accretion of CaCO3 by crustose coralline algae. Pre- and post-deployment scans will be aligned and subtracted to show the total volume of lost substrate and the size, shape, and location of excavation sites. The size, shape, and location of the excavation sites will be used to associate particular taxa with particular excavation types. Depending on the organism and the quality of preservation, organisms associated with particular excavation sites will be identified by morphology and/or DNA sequence. We will develop a model based on excavation characteristics that will predict the taxon associated with a particular excavation based on its location

and dimensions. Finally, the entire block and all associated tissue will be homogenized and run on ReefChip to describe bioeroder community composition.

The calcium carbonate blocks will remain on the reef for one year and retrieved on a cruise in 2012. If possible, we will co-locate our deployments with current NOAA-CRED ARMS or CAU deployments to facilitate retrieval in 2012. Although we plan to retrieve these blocks on a 2012 cruise, we want to be clear that, if necessary, a later retrieval will still allow us to answer the questions posed here.

NOTE: If land or marine archeological activities are involved, contact the Monument Permit Coordinator at the address on the general application form before proceeding, as a customized application will be needed. For more information, contact the Monument office on the first page of this application.

9a. Collection of specimens - collecting activities (would apply to any activity): organisms or objects (List of species, if applicable, attach additional sheets if necessary):

Common name:
We will be collecting pieces of dead Porites compressa skeleton. Dead coral skeleton harbors a diverse community of bioeroding organisms that has not been systematically targeted for study previously in the PMNM. One of the goals of this project is to more thoroughly document the composition of the bioeroding community in the PMNM. Based on studies in the MHI and previous work of the Census of Marine Life, we anticipate a wide variety of sponges and marine worms, as well as hydrozoans, bryozoans, barnacles, tiny mollusks, and turf algae. We expect a subset of these organisms will settle on our deployed blocks of calcium carbonate. Although we cannot give a specific list of the numbers of individual species we will find in samples, we have attached an excel sheet with a list of bioeroders and and other organisms that commonly settle on coral skeleton in Kaneohe Bay, Oahu (based on White 1980 and our own observations).

We will be collecting up to 26.15L of seawater at each site. Total seawater collected in the Monument will not exceed 261.5L.

Scientific name:
dead Porites compressa skeleton

& size of specimens:
up to 200 pieces, 5x5x5 cm each (total: 0.025 cubic meters)

Seawater samples: 26.15L per site at each of 8-10 sites. Total seawater collected will not exceed 261.5L.

Collection location:
20 pieces per site at 8-10 sites; specific locations will depend on cruise logistics

☒ Whole Organism ☒ Partial Organism

9b. What will be done with the specimens after the project has ended?
Preserved samples remain the property of the Monument and will be made available to others requesting access to these materials through the appropriate permit process. PI Donahue will maintain a database of samples and provide for the storage of all samples collected at HIMB until they are consumed by the study or such time as the Monument co-trustees request that they be returned to them. Taxonomic voucher specimens will be submitted for permanent inclusion in the Bishop and Smithsonian museum collections as per the terms of material transfer agreement.

9c. Will the organisms be kept alive after collection? ☐ **Yes** ☒ **No**

• General site/location for collections:

• Is it an open or closed system? ☐ Open ☐ Closed

• Is there an outfall? ☐ Yes ☐ No

• Will these organisms be housed with other organisms? If so, what are the other organisms?

• Will organisms be released?
no

10. If applicable, how will the collected samples or specimens be transported out of the Monument?
Calcium carbonate blocks and samples of dead coral tissue will be preserved for genetic analyses (in ethanol or saturated salt buffer, see details below) and transported back to HIMB aboard the R/V Hi'ialakai. Water samples will be stored frozed or fixed (with mercuric chloride, see details below) aboard the Hi'ialakai and transported back to HIMB. See attached MSDS sheets.

11. Describe collaborative activities to share samples, reduce duplicative sampling, or duplicative research:
All HIMB researchers working on similar species have coordinated to share samples and avoid duplicate sampling. This project reflects this coordination, as a joint effort between the Donahue, Thomas, and Toonen laboratories. HIMB and NOAA monument staff hold semiannual meeting and annual meetings with other agencies working in the monument so that research projects and

resources available are widely known. To my knowledge, no other systematic collections of internal bioeroders and measures of bioerosion rates have been made in the Monument.

Anticipated sharing of collections:
Samples of bioeroders in dead P. compressa skeleton: We anticipate doing most of the sample processing at HIMB, including extracting bioeroding organisms from the samples, most morphological inspection, DNA extraction, and running on the ReefChip microarray. DNA extracted from some samples may be sent out for sequencing to facilities on UH Manoa main campus or off campus. It is likely that we will need to send some extracted specimens for additional taxonomic identification to UH Manoa main campus, the Bishop Museum, or taxonomic specialists abroad. Taxonomic specialists are few and far between; therefore, we request the flexibility to share specimens with the appropriate specialists to help identify difficult taxa that we cannot identify on our own.

Water samples: We expect to run TA and nutrient samples at HIMB (pH analyses will be run shipboard). The TA analyses will be run in the HIMB Core facility by personnel from my lab. The nutrient analyses will be run in the Atkinson lab at HIMB by personnel from my lab. If problems arise with nutrient analyses at HIMB, we will send our water samples to an analytical chemistry laboratory on the mainland. Flexibility in the location of analysis will ensure that the samples derived from the Monument are analyzed in the most timely and accurate manner.

12a. List all specialized gear and materials to be used in this activity:
• Divers will use standard open-circuit SCUBA and snorkling equipment.
• Surveys of microhabitat variation will use a Nortek AS Vector velocimeter, a Nortek AS Vectrino velocimeter, two YSI multiparameter sondes.
• Measurement of retention time in reef crevices will use rhodamine WT fluorescent dye and syringes for water sampling.
• Calcium carbonate blocks will be attached to the reef using cable ties and Z-Spar 788 Splash Zone Epoxy,
• We will map out the sites and document the study using underwater cameras and meter tapes.
• Water samples for nutrients, pH, and total alkalinity will be taken using syringes. On the ship, these samples will be frozen or fixed with mercuric chloride.
• On the ship, samples of dead coral skeleton will be placed in plastic containers filled with ethyl alcohol or salt-saturated dimethyl sulfate.

12b. List all Hazardous Materials you propose to take to and use within the Monument:
Tissue preservative solutions for DNA analyses include: 95% ethanol (EtOH) and saturated salt buffer with dimethylsulfoxide (DMSO). Water samples for analysis of total alkalinity must be fixed with mercuric chloride.To measure pH shipboard, we will use 2mM m-cresol purple indicator dye. To measure water retention in the reef, we plan to use rhodamine WT, a fluorescent dye. To affix blocks to the substrate, we will use A-788 splash zone compound. MSDS sheets attached.

13. Describe any fixed installations and instrumentation proposed to be set in the Monument:

The proposed project includes 20 blocks of calcium carbonate to be installed as settling substrate for bioeroders at each of 8-10 study sites. These blocks will be attached to areas of bare rock with marine epoxy and cable ties. These blocks will remain in the monument for one year and will be retrieved on a cruise in 2012. The proposed project also includes short 1-5 day deployments of a Nortek AS Vector and a YSI multiparameter sonde at sites that we will return to over consecutive cruise days. I.e., if we are at a site for 3 days deploying calcium carbonate blocks and measuring microhabitat variation, the Nortek AS Vector and one YSI multiparameter sonde will be left to continuously record the physical environment for the entire 3 days. The fixed array will be affixed to the bottom using either (i) on a single, weighted sled deployed on non-coral substrate or (ii) attached to a fence post pounded into soft substrate near the reef. The choice of attachment will be made on site to minimize potential damage to the reef and minimize potential loss of the instruments; this decision will depend on the depth, bottom topography, and local wave conditions during our visit to the site. This temporary installation will be removed when we move to another site.

14. Provide a time line for sample analysis, data analysis, write-up and publication of information:

Analysis of physical environmental data will start immediately after collection of data in the field. Water sample analysis will occur within 2 months of returning from the cruise. Analysis of bioeroders in the pieces of dead coral skeleton will take longer, as it requires dissolution of the calcium carbonate, vouchering of specimens, DNA extraction and sequencing, and running the entire sample on the ReefChip. We anticipate that extraction of organisms, vouchering of specimens, and DNA extraction and sequencing will take place within one year of returning from the cruise, followed by ReefChip microarray analysis of dead coral skeleton samples. Once the calcium carbonate blocks are retrieved in 2012, we will send them to the microCT laboratory at Cornell University to be scanned. Upon return, these coral blocks will be homogenized and run on the ReefChip microarray to identify organisms. We expect that analysis of microhabitat variation will be completed and submitted for publication within one year of the cruise. The analysis of associations between microhabitat and bioeroder communities in environmental samples of dead coral skeleton will be completed and submitted for publication within two years of the cruise. Analysis of bioerosion rates along the Archipelago and analysis of bioeroder community composition will be completed with 2-3 years of the initial cruise date (and 1-2 years of the retrieval cruise).

Regardless of the time to publication, the results from these studies are made available to Monument managers as quickly as possible through the brown-bag luncheons, semi-annual reports, and semi-annual mini symposium during which all researchers involved in this project present the most current findings from their ongoing research to the broader management community. We also reach the NGO community and general public each year with presentations at the Hawaii Conservation Conference, Hanauma Bay seminar series, and other education and outreach venues. In sum, these efforts ensure that research results are provided to the Monument co-trustees almost as quickly as they become available, and made available to the greater management community within no more than 6 months of the data being collected.

15. List all Applicants' publications directly related to the proposed project:

This is a new project, and we do not yet have published results. Please see the attached CVs for other publications that are not directly related to the project.

With knowledge of the penalties for false or incomplete statements, as provided by 18 U.S.C. 1001, and for perjury, as provided by 18 U.S.C. 1621, I hereby certify to the best of my abilities under penalty of perjury of that the information I have provided on this application form is true and correct. I agree that the Co-Trustees may post this application in its entirety on the Internet. I understand that the Co-Trustees will consider deleting all information that I have identified as "confidential" prior to posting the application.

Signature Date

SEND ONE SIGNED APPLICATION VIA MAIL TO THE MONUMENT OFFICE BELOW:

Papahānaumokuākea Marine National Monument Permit Coordinator
6600 Kalaniana'ole Hwy. # 300
Honolulu, HI 96825
FAX: (808) 397-2662

DID YOU INCLUDE THESE?
☒ Applicant CV/Resume/Biography
☒ Intended field Principal Investigator CV/Resume/Biography
☒ Electronic and Hard Copy of Application with Signature
☒ Statement of information you wish to be kept confidential
☒ Material Safety Data Sheets for Hazardous Materials

Papahānaumokuākea Marine National Monument
Compliance Information Sheet

1. Updated list of personnel to be covered by permit. List all personnel names and their roles here (e.g. John Doe, Diver; Jane Doe, Field Technician, Jerry Doe, Medical Assistant): Megan Donahue (PI, Diver), Nyssa Silbiger (Graduate Assistant, Diver), Oscar Guadayol i Roig (Postdoctoral Researcher, Diver)

2. Specific Site Location(s): (Attach copies of specific collection locations): Based on current tentative cruise plans, we will install bioerosion blocks at forereef sites currently used by NOAA's Coral Reef Ecosystem Division for CAUs (Calcification Autonomous Units) at French Frigate Shoals, Pearl & Hermes, and Lisianski. At Midway and Maro, we will look at exchange rates between reef microhabitats and the overlying water by measuring retention times. We also plan to install bioerosion blocks at one lagoon site at Midway.

3. Other permits (list and attach documentation of all other related Federal or State permits): None

3a. For each of the permits listed, identify any permit violations or any permit that was suspended, amended, modified or revoked for cause. Explain the circumstances surrounding the violation or permit suspension, amendment, modification or revocation.

4. Funding sources (Attach copies of your budget, specific to proposed activities under this permit and include funding sources. See instructions for more information): The costs of the project, including microCT scans ($22,500) and water sample processing ($5,000), will be covered by start-up funds from PI Donahue, if submitted grant proposals are unsuccessful. Salary for RA Silbiger, who will be processing the samples, is funded by the NSF EPSCoR grant to the University of Hawaii. Roig is a postdoc with Dr. Flo Thomas, one of our collaborators on this project, and is funded by the NWHI-HIMB partnership. All sensor equipment for *in situ* monitoring is provided by Dr. Thomas.

5. Time frame:
Activity start: July 23, 2011
Activity completion: Dec 31, 2012

F-3b

Dates actively inside the Monument:
From: July 23, 2011
To: Aug 20, 2011

Describe any limiting factors in declaring specific dates of the proposed activity at the time of application:
Currently, we have estimated dates for this the 2011 cruise of July 23-Aug 20, 2011 when the bioerosion blocks will be deployed, and we will perform *in situ* measurements of water exchange between reef microhabitats and the overlying water. We do not yet know the dates for bioerosion block retrieval next year. We anticipate that blocks will be retrieved on either/both the CRED cruise or the PMNM cruise before the end of 2012.

Personnel schedule in the Monument: Donahue, Silbiger, and Roig will be in the monument on the R/V Hi'ialakai, currently scheduled for July 23-Aug 20, 2011. Silbiger will be on the retrieval cruise, but other personnel for the 2012 cruise and dates of the 2012 cruise are not yet determined.

6. Indicate (with attached documentation) what insurance policies, bonding coverage, and/or financial resources are in place to pay for or reimburse the Monument trustees for the necessary search and rescue, evacuation, and/or removal of any or all persons covered by the permit from the Monument:
All divers are requested to carry DAN insurance in addition to UH workers compensation that will cover any diving related injury or an accident that occurs while on a diving research cruise.

7. Check the appropriate box to indicate how personnel will enter the Monument:

x☐ Vessel
☐ Aircraft

Provide Vessel and Aircraft information: NOAA R/V Hi'ialakai

8. The certifications/inspections (below) must be completed prior to departure for vessels (and associated tenders) entering the Monument. Fill in scheduled date (attach documentation):

☐ Rodent free, Date:
☐ Tender vessel, Date:
☐ Ballast water, Date:

☐ Gear/equipment, Date:
☐ Hull inspection, Date:

9. Vessel information (NOTE: if you are traveling aboard a National Oceanic and Atmospheric Administration vessel, skip this question):
Vessel name:
Vessel owner:
Captain's name:
IMO#:
Vessel ID#:
Flag:
Vessel type:
Call sign:
Embarkation port:
Last port vessel will have been at prior to this embarkation:
Length:
Gross tonnage:
Total ballast water capacity volume (m3):
Total number of ballast water tanks on ship:
Total fuel capacity:
Total number of fuel tanks on ship:
Marine Sanitation Device:
Type:

Explain in detail how you will comply with the regulations regarding discharge in the Monument. Describe in detail. If applicable, attach schematics of the vessel's discharge and treatment systems:

Other fuel/hazardous materials to be carried on board and amounts:

Provide proof of a National Oceanic and Atmospheric Administration (NOAA) Office of Law Enforcement-approved Vessel Monitoring System (VMS). Provide the name and contact information of the contractor responsible for installing the VMS system. Also describe VMS unit name and type:

VMS Email:
Inmarsat ID#:

* Individuals MUST ENSURE that a type-approved VMS unit is installed and that its automatic position reports are being properly received by the NOAA OLE system prior to the issuance of a permit. To make sure your VMS is properly configured for the NOAA OLE system, please contact NOAA OLE at (808) 203-2503 or (808) 203-2500.

* PERMITS WILL NOT BE ISSUED TO INDIVIDUALS ENTERING THE MONUMENT VIA VESSEL UNTIL NOAA OLE HAS CONTACTED THE MONUMENT PERMIT COORDINATOR WITH A 'POSITIVE CHECK' READING.

10. Tender information:

On what workboats (tenders) will personnel, gear and materials be transported within the Monument? List the number of tenders/skiffs aboard and specific types of motors:

Additional Information for Land Based Operations

11. Proposed movement of personnel, gear, materials, and, if applicable, samples:

12. Room and board requirements on island:

13. Work space needs:

DID YOU INCLUDE THESE?

- ☐ Map(s) or GPS point(s) of Project Location(s), if applicable
- ☐ Funding Proposal(s)
- ☐ Funding and Award Documentation, if already received
- ☐ Documentation of Insurance, if already received
- ☐ Documentation of Inspections
- ☐ Documentation of all required Federal and State Permits or applications for permits

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

WILLIAM J. AILA, JR.
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

GUY KAULUKUKUI
FIRST DEPUTY

WILLIAM M. TAM
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET, ROOM 330
HONOLULU, HAWAII 96813

June 9, 2011

TO: Division of Aquatic Resources File

THROUGH: William J. Aila, Jr., Chairperson

FROM: Francis Oishi
Division of Aquatic Resources

DECLARATION OF EXEMPTION FROM THE PREPARATION OF AN ENVIRONMENTAL ASSESSMENT UNDER THE AUTHORITY OF CHAPTER 343, HRS AND CHAPTER 11-200 HAR, FOR PAPAHĀNAUMOKUĀKEA MARINE NATIONAL MONUMENT RESEARCH PERMIT TO MEGAN DONAHUE, UNIVERSITY OF HAWAII, HAWAII INSTITUTE OF MARINE BIOLOGY, FOR ACCESS TO STATE WATERS TO CONDUCT BIOEROSION STUDY ACTIVITIES UNDER PERMIT PMNM-2010-032

The following permitted activities are found to be exempted from preparation of an environmental assessment under the authority of Chapter 343, HRS and Chapter 11-200, HAR:

Project Title:
Papahānaumokuākea Marine National Monument Research Permit to Megan Donahue, University of Hawaii, Hawaii Institute of Marine Biology, for Access to State Waters to Conduct Bioerosion Study Activities

Permit Number: PMNM-2011-032

Project Description:
The research permit application, as described below, would allow entry and activities to occur in Papahānaumokuākea Marine National Monument (Monument), including the NWHI State waters from June 1, 2011 through November 30, 2011.

This project is to measure bioerosion rates, bioeroder community composition (i.e. hydrozoans, bryozoans, barnacles, and tiny mollusks) and physical parameters of their associated microhabitats at up to 10 different reef sites in Papahanaumokuakea Marine National Monument. The purpose of these activities is to test the effectiveness of using bioerosion rates and bioeroder communities as indicators of climate change, specifically ocean acidification. The activities in the permit would include placing calcium carbonate blocks as settling substrate for bioeroders; deploying a temporary sensor array to measure temperature, pH, salinity, and oxygen concentration at each site; collecting water and dead coral samples; and using a water tracing dye to measure water retention in crevice sites.

The proposed activities are in direct support of the Monument Management Plan's priority management need 3.1 – Understanding and Interpreting the NWHI (through action plan 3.1.1 – Marine Conservation Science). This action plan specifies to conduct "marine research, characterization, and monitoring designed to support an ecosystem-based approach to protection and management". It also notes that monitoring data can help scientists understand causes of change. Activities to support marine conservation science, including community composition and change studies such as those to be carried out by the permittee, are also addressed in the Monument Management Plan Environmental Assessment (December 2008) which resulted in FONSI. This EA summarizes that understanding the populations change could be helpful to forecast, prepare for and mediate potential threats to populations within the Monument (PMNM MMP Vol. 2, p.171). Measurements of bioersion rates and community composition, such as those proposed, would enhance this understanding.

Consulted Parties:
The permit application was sent out for review and comment to the following scientific and cultural entities: Hawaii Division of Aquatic Resources, Hawaii Division of Forestry and Wildlife, Papahānaumokuākea Marine National Monument (NOAA/NOS), NOAA Pacific Islands Regional Office (NOAA-PIRO), United States Fish and Wildlife Service Hawaiian and Pacific Islands National Wildlife Refuge Complex Office, and the Office of Hawaiian Affairs (OHA). In addition, the permit application has been posted on the Monument Web site since March 10th, giving the public an opportunity to comment. The application was posted within 40 days of its receipt, in accordance with the Monument's Public Notification Policy.

Exemption Determination:
After reviewing HAR § 11-200-8, including the criteria used to determine significance under HAR § 11-200-12, DLNR has concluded that the activities under this permit would have minimal or no significant effect on the environment and that issuance of the permit is categorically exempt from the requirement to prepare an environmental assessment based on the following analysis:

1. All activities associated with this permit, including the measuring of bioeroder rates and community compostion, have been evaluated as a single action. As a preliminary matter, multiple or phased actions, such as when a group of actions are part of a larger undertaking, or when an individual project is precedent to or represents a commitment to a larger project, must be grouped together and evaluated as a single action. HAR § 11-200-7. Since this permit involves an activity that is precedent to a later planned activity, i.e. the retrieval of the calcium carbonate blocks, the categorical exemption determination here will treat all planned activities as a single action.

2. The Exemption Class for Scientific Research with no Serious or Major Environmental Disturbance Appears to Apply. Chapter 343, HRS, and § 11-200-8, HAR, provide for a list of classes of actions exempt from environmental assessment requirements. HAR §11-200-8.A.5. exempts the class of actions which involve "basic data collection, research, experimental management, and resource evaluation activities which do not result in a serious or major disturbance to an environmental resource." This exemption class has been interpreted to include fish collection for marine surveys and research, as well as research related to the development and management of various aquatic organisms, including life history, migration, and growth studies, such as those being proposed.

In addition Exemption Class #5, Exempt Item #5 includes "surveys, censuses, inventories, studies . . . collection, culture and captive propagation of aquatic biota." DEPARTMENT OF LAND & NATURAL RESOURCES, EXEMPTION LIST FOR THE DIVISION OF FISH AND GAME 3-4 (January 19, 1976).

The proposed measuring of bioerosion rates and community composition activities here appear to fall squarely under the exemption class identified under HAR § 11-200-8.A.5. As discussed below, no significant disturbance to any environmental resource is anticipated from the collection of water and dead coral, nor from the placing of instruments and settlement blocks. Thus, so long as the below considerations are met, an exemption class should include the action now contemplated.

3. Cumulative Impacts of Actions in the Same Place and Impacts with Respect to the Potentially Particularly Sensitive Environment Will Not be Significant. Even where a categorical exemption appears to include a proposed action, the action cannot be declared exempt if "the cumulative impact of planned successive actions in the same place, over time, is significant, or when an action that is normally insignificant in its impact on the environment may be significant in a particularly sensitive environment." HAR § 11-200-8.B. To gauge whether a significant impact or effect is probable, an exempting agency must consider every phase of a proposed action, any expected primary and secondary consequences, the long-term and short-term effects of the action, the overall and cumulative effect of the action, and the sum effects of an action on the quality of the environment. HAR § 11-200-12. Examples of actions which commonly have a significant effect on the environment are listed under HAR § 11-200-12.

No prior studies of this type have been undertaken to date. This project would be the first systematic documentation of internal bioeroders and their respective bioerosion rates in the Monument. However, the majority of activities to be carried out (collections, instrument and block deployments) are standard marine research tasks that have been used in the Monument before, with no deleterious impacts. The new activity involving the use of a water tracing dye is also expected to have no negative impacts, as it is being used in low concentrations that are safe enough to use in drinking water. With this in mind, significant cumulative impacts are not anticipated as a result of this activity, and numerous safeguards further ensure that the potentially sensitive environment of the project area will not be significantly affected. All activities will be conducted in a manner compatible with the management direction of the Monument Proclamation in that the activities do not diminish monument resources, qualities, and ecological integrity, or have any indirect, secondary, cultural, or cumulative effects. The joint permit review process did not reveal any anticipated indirect or cumulative impacts, nor did it raise any cultural concerns, that would occur as a result of these activities.

The activities would be conducted from the NOAA Ship HI'IALAKAI (PMNM-2011-009) during its July/August cruise. The following table lists additional activities that are anticipated to take place on this cruise pending approval of permit applications.

Table 1. Concurrent Projects Aboard NOAA SHIP HI'IALAKAI

Permit	Purpose and Scope	Location
PMNM-2011-009 NOAA Ship HI'IALAKAI	The permit allows NOAA Ship HI'IALAKAI entry into PMNM. Personnel aboard the vessel will be permitted under separate permits.	All locations
PMNM-2011-020 Aeby (proposed)	The proposed action is to allow collection of reef fish and corals for disease studies as well as monitoring for diseased corals	All locations
PMNM-2011-021 Winn (proposed)	The proposed action is to allow water sampling.	All locations
PMNM-2011-023 Au (proposed)	The proposed action is to allow deployment and retrieval of acoustic receivers.	Kure, Lisianski, FFS, Nihoa
PMNM-2011-027 Thomas (proposed)	The proposed action is to allow collection of algae, bivalves and water samples.	All locations
PMNM-2011-032 Godwin	The permitted action is to allow monitoring activities and collection of unknown or unidentifiable invertebrate and algal species as well as diseased coral species	All locations

Two additional proposed activities include collection of water samples. Given the benign nature of collecting water however, the duplicative aspect of these activities is negligible. While the Applicant is also collecting coral samples, her samples are of dead coral only and therefore do not overlap with other proposed coral collections.

The culmination of these permits, and their disparate activities, occurring throughout the Monument over a 4-week period, is not anticipated to have significant cumulative impacts. The NOAA Ship OSCAR ELTON SETTE (PMNM-2011-008) may also be in the Monument during this time frame facilitating needs of the monk seal camps under the management permit (PMNM-2011-001).

Since no significant cumulative impacts or significant impacts with respect to any particularly sensitive aspect of the project area are anticipated, the categorical exemptions identified above should remain applicable.

4. Overall Impacts will Probably be Minimal and Insignificant. Any foreseeable impacts from the proposed activity will probably be minimal, and further mitigated by general and specific conditions attached to the permit. Specifically, all research activities covered by this permit will be carried out with strict safeguards for the natural, historic, and cultural resources of the Monument as required by Presidential Proclamation 8031, other applicable law and agency policies and standard operating procedures.

Conclusion. Upon consideration of the permit to be approved by the Board of Land and Natural Resources, the potential effects of the above listed project as provided by Chapter 343, HRS and Chapter 11-200 HAR, have been determined to be of probable minimal or no significant effect on the environment and exempt from the preparation of an environmental assessment.

_____ _____

William J. Aila, Jr. Date
Board of Land and Natural Resources